

SPEECH TRAINING AIDS FOR SMALL CHILDREN

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INTRODUCTION

The purpose of this is to describe a simple speech training aid for use by speech therapists in their work. In particular, the paper will focus on the design requirements of such a device. The paper will first describe the background and requirements, it will then describe the device.

BACKGROUND AND CONTEXT

As the training aid was intended for use by speech therapists it would be useful to briefly consider what they have to do when dealing with a child with a speech disorder.

The speech therapist first of all will establish what the child's disorder entails and what its causes might be. Causes can vary but they might entail some oral abnormality such as too low a palate, or a slow clumsy articulation arising from dysfunction of the muscles used in speech (dysarthria), or possibly one of a number of problems in ordering the sounds in a word (dyspraxia), or possibly an inability to comprehend and formulate speech (Aphasia). Sometimes the problem is due to social background that discourages children from speaking.

In any case the speech therapist must diagnose the problem and formulate a strategy of treatment. M Morley [1] describes the therapist's aim as this: "to help each child to obtain speech which is useful for the purpose of communication, which is appropriate for his age, development and environment, and which does not attract undue attention as the result of any abnormalities". It is not the therapist's task to worry about accent, elocution or particularly content.

Each patient of course is different as described by Morley [1]. "Each child presents an individual problem, and treatment for defective articulation must be varied and designed to meet the level of intelligence, the stage of language development and any neurological or structural condition which may influence articulation." However generally there are four processes to go through in order to encourage motor learning for articulation, these are inhibition, facilitation, association and stabilisation. Inhibition involves inhibiting the old faulty sensori-motor pattern so that a new one can be substituted, it is more often an unvoiced consonant which needs replacing. Facilitation involves building the new and correct sound, the child's abilities so far are used here, for example, by starting with a voiced or unvoiced consonant which they already know. Association of the new sound is the next stage, this involves linking it with other parts of speech (probably a vowel sound) in preparation for fitting them in with words. Stabilisation which involves ingraining the new sound, is the next stage, this is accomplished by practising. It seems that the sensori-motor experience is more

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important than reasoning in acquiring or changing motor skill, and that once acquired they will hopefully begin to manifest themselves in normal speech.

The position which this aid might operate in the treatment is in developing the sounds and practising them. "Babbling" is the practice of repeating sounds over and over in order to gain the motor skills necessary for a new sound, for instance a child might repeat (k-a: k-a: k-a:) or (sssssa, sssssa), thus new patterns are developed which will as described hopefully incorporate themselves in speech. The system will provide feedback for the child in terms of visual stimuli from a computer screen to their articulation. This might be so that they can just see their changes in volume to encourage them to experiment of it may be in the form of games of various sophistication chosen by the speech therapist to encourage various aspects. Play is an important tool in the therapist's armoury and such a system provides a tool box of new games and techniques for the therapist.

An example of the sort of game currently available would be the 'Sid and Mike' package used with the prototype system. This allows a range of exercises to be conducted. For instance 'Sid' would catch a passing umbrella if a sound was made as the umbrella floated by, he would then float up the screen with the umbrella. Similarly he would descend by grabbing a passing weight on the child's vocal signal. On the same package is a program which has 'Sid' drinking a glass of lemonade. Sid drinks up a straw when the child makes a noise and he continues to drink as long as the child makes the noise, finally finishing his glass of lemonade and jumping up and down. If the child fails to sustain the noise then the glass refills and they have to start again. For an older child it might be better to have an option which allows them to control a left (voiced) and right (unvoiced) joystick type motion on home leisure software such as space invaders, the system could also let them 'fire' by making sounds.

It might seem that the child could be distracted from the vocal exercise by trying to save earth from the space invaders of whatever the game on hand is, however such distraction is not a disadvantage as it helps their repetition get through subconsciously; Morley [1] states when discussing the use of picture story cards in therapy, "They should contain pictures which will divert attention, so that imitation of the therapist's articulation of words is carried out at as unconscious a level as possible." Obviously if there is a variety of games to play the therapist can choose one which will keep the child's interest and hence encourage the all-important repetitions.

Thus we can see that a training aid could be used to enhance the stages of the therapy process which require effort and repetition from the patient by rewarding them for that effort. Clearly to be useful the reward offered by the training aid must be suitable for the child.

CHILD CHARACTERISTICS

Small children have several characteristics which significantly affect the design of a speech training aid. These are:

a) Simplicity

Small children are attracted by simple but exciting (to them) objects. Highly complex displays

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can be both confusing and paradoxically less exciting.

b) Short attention span

Small children tend not to concentrate on any one task for a long period of time. Instead they tend to flit from task to task. This means any training activity or aid which requires sustained attention is likely to be less successful.

c) Playing

Small children explore and test their environment and try out different things with the objects in their environment. This playing with the environment forms a significant, and enjoyable, part of their learning.

d) Home/"Mother" centred lifestyle.

The pre-school child spends most of his time at home interacting with his mother (or someone who fulfils that role). The ability to receive the necessary stimulation and training as part of the home environment is a necessity. Therefore speech training aids need to be able to be used at home if they are to be truly effective.

The whole implication of the above requirements is that simplicity is an important factor of the design of a training aid. However there are other problems. A speech therapist who used existing training aids identified the following problems:

- 1 There is no indication of volume level to go with the volume adjustment.
- 2 There is difficulty with children mistreating the microphone, this might mean that they have a tendency to dribble on it or even to put it in their mouth. They may also be intimidated by the microphone.
- 3 There is no ability to control speed of the games software.

From these considerations we identified the following specification for the training aid:

The standard BBC model B is already in use (both at the local hospitals and in education roles generally) so the system has been designed for this machine.

- a) To build a system capable of offering all the facilities of the current system used by the speech therapist.
- b) Give an indication of the signal level, to allow gain adjustment.
- c) Find a solution to the problem of children's reaction to the microphone.
- d) Overcome the problem of the inability of the speech therapist to control games software.

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- e) The system should allow the child to train using voiced or unvoiced speech or a combination of the two.
- f) The system should offer a variety of options and use the standard joystick port so that a variety of commercially available software could be used.
- g) It must be possible to produce the system for £100 or less.

DESCRIPTION OF THE TRAINING AID

A block diagram of the circuitry in the training aid is shown in Figure 1. The functions of the different parts of the system are as follows:

1 Microphone

There are two problems with the use of the microphone, one is that of the microphone being mistreated (by the child sucking it or dribbling on it) and thus getting wet. The other is the childrens' response to the microphone and how intimidating they find it. This was solved by using a surface mounting microphone which does not look intimidating and can sit in from of the child as they talk. Such a 'PZM Microphone' was used in this project. Its shape means that a child's toy could be sat beside it so that the younger children can be asked to "talk to teddy", as shown in Figure 2.

2 Amp

The amplifier (at the front end) must take the signal and bring it up to a suitable level to be non-clipping but large enough to ensure that a good signal to noise ratio is maintained. Here the requirement for amplification adjustment was fulfilled.

3 Filters

These are used to separate voiced and unvoiced components of speech in line with requirement (e). The cut off frequencies and order were similar to that of Knorr [2].

4 Rectifier and Amp

Looking at these together they must provide a smooth D.C. signal which varies with input amplitude. The amplifying at this point should amplify such that it is possible to cover the whole of the A/D input range so that the signal is at the correct level for the computer joystick inputs.

5 Fire Buttons

These pieces of circuitry must compare the voiced or unvoiced level with a threshold and the outputs from them go low when the threshold is exceeded. There is also a hardware fire button and fire indicators.

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6 Signal Adder

This circuitry subtracts the voiced signal from the other and then adds to this an offset of half the range to imitate a joystick.

7 Computer Connection Switches

These allow the user to set, in conjunction with the software, whether the game is controlled by the voiced, unvoiced or combination signals. They also allow the user to set which signal triggers the fire buttons, voiced, unvoiced or manual.

8 Level Indicators

This circuitry, examines the levels of the voiced and unvoiced signals as the computer will see them and gives a visual indication of their level on LED's.

DISCUSSION

The system described above was implemented and worked with both existing speech therapy software, and commercial games software, running on the BBC. The cost of the components was less than £20 which would allow a selling price of under £100 if such a unit was produced commercially for speech therapists.

However, given that the device can control existing games software it would be worth considering using it in the games market.

This would provide a larger scale of manufacture and marketing resulting in a lower cost device. If the device could be priced lower due to large scale production runs then it might be possible that some home users would be interested in the novelty value of this cheap system for voice control given that it is designed to work with commercially-available software for joysticks. It is certainly the case that some of our colleagues expressed more than usual polite or technical interest in testing the device!

CONCLUSION

A simple speech training aid has been described. Although simple, it provides the necessary functionality for the job. It is also affordable by the people who can most benefit from the technology, the speech therapist and their patients.

REFERENCES

- 1 Muriel E Morley, 'Development Disorders of Speech in Childhood', E & S Livingstone Limited, 1957.
- 2 Siegfried G Knorr, 'Reliable Voiced/Unvoiced Decision', IEE Transaction on Acoustics, Speech and Signal Processing, June 79 p 263.

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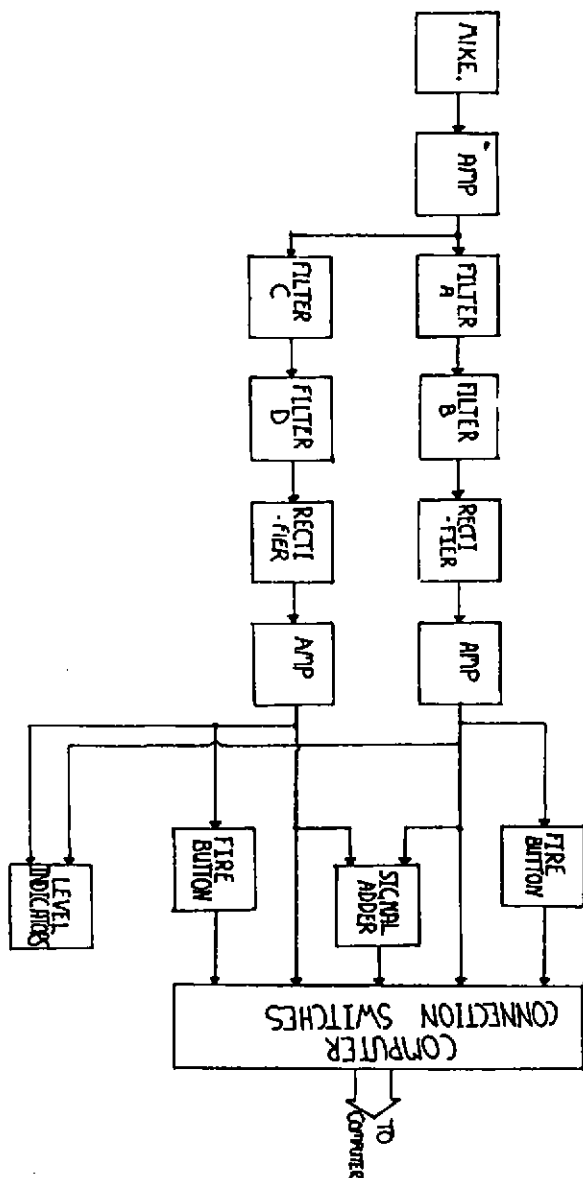


Figure 1 A Block Diagram of the Training Aid

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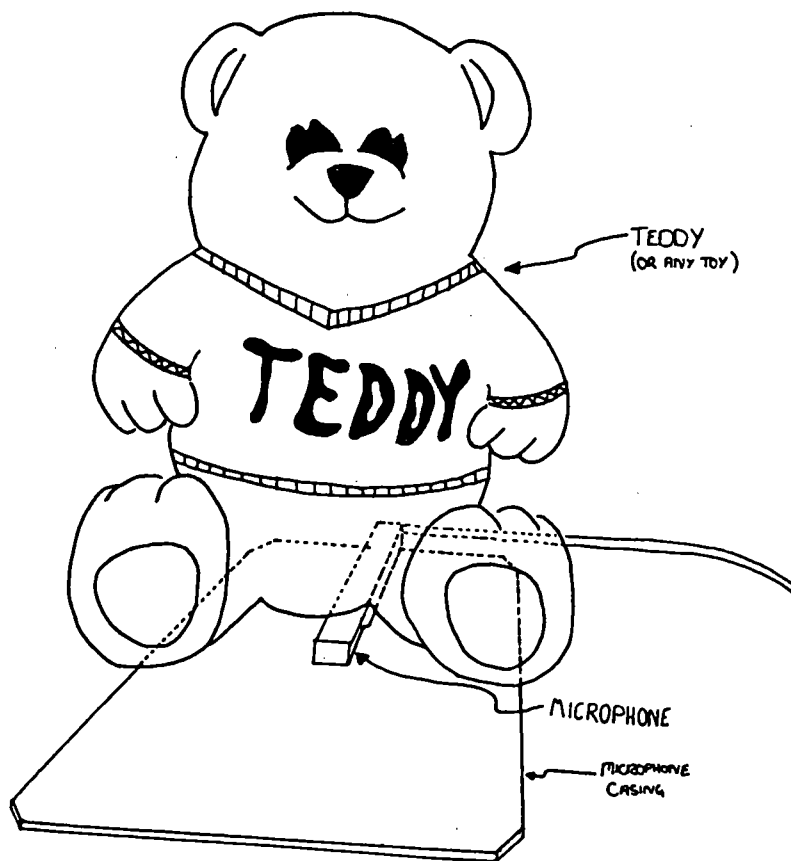


Figure 2 'PZM' Microphone and Teddy

